

referred to will prove that my recollection is right. At any rate the mounting referred to agrees absolutely with the specimen here described from Polperro as *C. Montagui* (A).

On the Salivary Apparatus of Birds. By Dr. A.-H. PILLIET.

The system of salivary glands appears to be somewhat slightly developed in birds, and there scarcely exist any comprehensive memoirs upon the subject.

This is due to the difficulty of isolating very small groups of glands buried beneath corneous membranes, of which the dry and apparently unlubricated surface negatives the very idea of a salivary secretion. Milne-Edwards barely devotes a few lines to the matter; these excretory organs, he states, have but little importance, and are only very imperfectly known. The fact is that Duvernoy, Meckel, Müller, Schold, Stannius, Chauveau, and Wiedersheim have only described glands large enough to be isolated by the scalpel—such as the sub-lingual gland of the goose, the palatine glands of the ostrich; the groups of glands of the woodpecker, the parrots, and the climbers; and even the descriptions of these authors convey the impression of isolated and not coordinated facts. Prof. Ranvier in his course of lectures for 1883* returned to the study of these glands, and gave a general description of them, while insisting that the classifications of the old anatomists were fallacious as a natural consequence of their method. As a matter of fact, by analogy with higher animals, parotid, sub-lingual, and submaxillary glands were described in the comparative anatomy of birds. Now, the morphological type represented by the bird, which is very far removed from that of mammals, on the contrary greatly resembles that of the Saurians and Chelonians: and it is with the members of the latter groups, in which the glands of the mouth and pharynx locate themselves where they can, and are spread out and hidden beneath a more or less rigid mucous membrane, that the bird must be compared.

We have studied the salivary glands of birds with respect both to their situation and their structure. The method of examination was as follows: the head was fixed by means of a preservative fluid, decalcified with picric acid supplemented with formic acid, hardened, and cut into slices. These successive manipulations are not without detriment to the study of the cellular substance, but they are of great service in enabling us to make out the situation of the groups of glands; and sections made from strips of excised mucous membrane have rendered it possible for us to give precision to the typographical information afforded by the broad slices.

I. ARRANGEMENT OF THE GLANDS.—a. *The upper jaw.*—In the duck the glands form very abundant groups in the upper jaw, especially at its centre. They do not exist at the base, and the

* L. Ranvier, *Journal de Micrographie*, 1884, p. 146.

groups cease towards the tip of the beak, where they are replaced by Herbst's corpuscles; the latter are so numerous that, in certain preparations, they are seen to entirely fill the cavities of the spongy bone which forms the skeleton of the beak. In the crow no glands are seen in the median third of the beak; the fowl, on the other hand, shows well the two palatine groups of glands, which are in contact the one with the other in the median line.

b. *The lower jaw and tongue.*—The study of the glands of the tongue is inseparable from that of the lower jaw. The organs are those which, in the species in which they are found, have been described under the name of sublingual and submaxillary glands. In the just-hatched chick frontal sections affecting the base of the tongue show two groups of glands of considerable size and another smaller one. The most important group opens by a series of orifices into the furrow which separates the tongue from the jaw. This group is composed of glandular lobes which are developed, not beneath the tongue, but in the floor of the mouth, beneath the mucous membrane which covers the mandible, and which almost come into contact with the bone. The second group of smaller size occupies the two corners of the tongue, which, in frontal sections, naturally presents the appearance of a triangle, with its base uppermost and the apex beneath serving for the insertion of the organ. In the two free corners of the tongue are found the groups of glands which penetrate into the interior, as far as the three bones, as yet in a cartilaginous condition, which form the skeleton of the organ.

The third group is situated in the actual thickness of the beak, at the level of its free edge and internally to the inner margin of the upper jaw (“en dedans du bord interne du maxillaire supérieur”); it is composed of somewhat small lobes, which open opposite the edges of the tongue, and consequently correspond to the glands of the second group.

In the tongue of the adult duck, the two islets which form our second group are greatly developed at the base, at the level of the fatty-fibrous cushion which reduplicates the mucous membrane; as has been shown by M. Ranvier, they are non-existent at the tip.

c. *The pharynx and œsophagus.*—In the chick some considerable time before it is hatched we find in the pharynx only very voluminous and greatly swollen epithelial buds, comparable to the buds of feathers, but penetrating inwards instead of projecting from the surface. They form two groups—the one anterior, which occupies the pharyngeal side of the laryngo-œsophageal septum, and the other posterior, composed of two lateral masses which come into contact in the median line. The house-sparrow furnishes us with the complete development of this simple condition, for in this species we may count as many as six distinct groups of glands—two median and four lateral ones.

The anterior median group is situated between the œsophagus and the larynx; it is quadrate in shape, and extends in breadth from one mucous membrane to the other, so that, although we have

not, however, succeeded in observing glandular orifices in the larynx, we may believe that it is common to the two mucous membranes with respect to which it is intermediate. The posterior median group is likewise quadrilateral in sections. The two lateral groups on each side are quite unequal as regards both volume and shape. The larger one occupies the pharyngeal commissure, and is therefore distinctly lateral in position; it is composed of well-developed and very bulky lobes. The second lateral group is situated between this and the posterior [median] group; it is composed of flattened lobes and forms an extended sheet, which, in certain specimens, may join the posterior group.

Of these glands, the lateral groups of the commissures are much the more important and descend into the œsophagus, where they form two wonderfully well-developed masses—especially in the duck, in which they continue as far as the glands of the crop, which are recognizable by the special characters described by Prof. Renant.

From this anatomical study it may be gathered that the salivary apparatus of birds is but seldom arranged in the form of bulky glands, but that it exists none the less and is very well developed, forming sheets beneath the mucous membrane, which are sometimes confluent. Since adipose tissue is altogether rare in the heads of birds, the anatomical character of these glands can be seen to perfection. They locate themselves where they can, between mucous membrane, bone, and muscle. This explains their apparent absence and their neglect by anatomists. Although this is apart from our subject, we might note here the presence of limited groups of glands in the nasal fossæ of the fowl.

II. STRUCTURE OF THE GLANDS.—As we have already stated, the glands are composite tubular organs. They arise first as a swollen bud which becomes hollowed out, and, instead of producing agminated swellings at its periphery, as in the case of the salivary glands of mammals, transforms itself into a sac, which bristles with papillary protuberances; hence we get three stages in these glands, stages which can be easily followed in the same animal, for we always find very small lobules side by side with others of full size (a condition which is likewise not met with in mammals). In its first stage the gland is utricular, scarcely composed of protuberances; it is, on a small scale, the *reticulum* of the stomach of the ox. In a more advanced stage these protuberances have risen; they have contracted the lumen of the glandular cavity and are charged with secreting cells, the result of which is that each protuberance or papillary compartment encloses a short tubular gland. Finally a third stage shows these glands individualized and uniting in a common excretory duct with a differentiated epithelium. The development of these villous and very vascular structures perhaps explains the fact, mentioned by M. Ranvier, that the lobes which are thus formed, and which attain the size of the head of a small pin, are not found to be each enveloped in a distinct basal membrane.

In a very partial degree there may be found in man glandular structures which are comparable to these, with extra-glandular papillary protuberances; we may mention the glands of the cervix uteri (Cornil) and those of the prostate (Regnaud).

The cells vary according to the glands. We have stated that the existence of serous glands was demonstrated by M. Ranvier. As a general rule, the smallest glandules, those which are utricular, are clothed with very narrow and greatly elongated caliciform cells, comparable to the elements of the cutaneous mucous glands of the frog. The glands of large size, which are situated at the base of the tongue and in the pharyngeal commissure, present a very granular appearance after being treated with hæmatoxylin; some are even opaque and fatty after being mounted in glycerine. We have shown in another paper* that it was possible to prove the mingling of aqueous and fatty secretions in the cutaneous glands of birds. It is therefore not surprising that we should meet with this fact again in a dermo-mucous gland.

But this analogy with the sebaceous glands ceases if we consider the excretory ducts. These are, as a matter of fact, clothed with a cubic epithelium, which continues through the layers of the epithelium of the mucous membrane, which are always very thick. The cells composing this epithelial lining are longitudinally striated, as in mammals, but their cytoplasm is much more opaque. The ducts are very wide and not infrequently exhibit papillary protuberances. They finally open with bell-shaped mouths at the bottom of the folds of the mucous membrane. The contents of the ducts are chiefly composed of desquamated cells, forming granular masses which fix the reagents and have not the characters of a mucous secretion, although the cells with which the glandular villi are loaded are almost all ovoid and caliciform.

The salivary glands of birds have therefore a special form, and their cells appear to be charged with very complex functions, since they secrete mucus, ferments, and fatty bodies.

Summary of results.—1. Salivary glands are abundant in birds, although concealed beneath the mucous membrane.

2. We must cease to class them according to the characters of the salivary glands of mammals, and on the contrary compare them with the glands of the lower vertebrates, as has already been stated to be necessary by Wiedersheim and M. Ranvier.

3. The type of the salivary glands is entirely similar to the general type of glands in birds, which is very peculiar, of which the structure, like the morphology, enables us to compare it with that of reptiles, while removing it from that of mammals. Herein we have a confirmation from the standpoint of general anatomy of the resemblances long since established by zoologists between birds and reptiles.—*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, 9^e sér. t. v. no. 12, March 31, 1893, pp. 349–352.

* A. Pilliet, "Note sur la glande sébacée des oiseaux et sur le type glandulaire dans cette classe de Vertébrés," Société Zoologique de France, June 11, 1889.